Research Report 1297

AN EXPERIMENT TO EVALUATE THE TRAINING POTENTIAL OF THE PILOTS' NIGHT TRAINING DEVICE

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Various constraints on low a[illegible]e night flight have acted to restrict the ability of Army aviation unit commanders to train their aviators in the essential pilot skills required for successful night terrain flight. Use of the Pilots' Night Training Device (PNTD) which attenuates daylight and simulates the night visual scene was tested in a controlled training situation. The posttest performance of two matched groups of Army aviators, one trained at night and the other trained using the Device during the daytime, was compared.

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The results indicated that the group trained in the daytime with the Device performed at least as well as the group trained at night. These results have implications for expanded use of the Device in field training.

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FOREWORD

This report describes a part of the second year's research accomplished by Canyon Research Group, Inc. (Canyon) for the US Army Research Institute for the Behavioral and Social Sciences (ARI) under Contract Number DAHC19-77-C-0059, "Development of Unit Training and Evaluation Techniques for Combat Ready Helicopter Pilots." Other research accomplished under this contract includes the development and testing of a Tactical Premission Planning Training Module, the development of performance assessment procedures and techniques, and the identification of additional areas for future module development. A summary report describing the entire research effort is in preparation.

JOSEPH ZEIDNER
Technical Director

ACKNOWLEDGEMENTS

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They are most appreciative for the responsive support of COL Stanley C. Knapp, Commander, US Army Aeromedical Research Laboratory, and particularly to Major David D. Glick, CPT Franklin F. Holley, Dr. Isaac Behar and Ms. Paula K. Store for their assistance in arranging and performing the dark adpatation screening of the subjects.

Major Paul B. Des Jardins, Mr. Hans D. Langhammer, and CW2 Charles E. Carr, ARI Field Unit, Fort Rucker, were major contributors to the development of the training and evaluating instruments and procedures, as well as participating as Instructors during the training phase of the experiment.

Without the aid and active interest of MG James H. Merryman, Commander, US Army Aviation Center (USAAVNC), the Deputy Commander, BG James H. Patterson, and the Director of Training, COL Kenneth J. Burton, the experiment could not have been accomplished.

Although it is not possible to list all the members of USAAVNC who contributed significantly to this research, acknowledgement must be made of the professional service rendered by the Evaluators, CW3 William F. Schwab and CW3 Charles P. Dyer who tested the performance of the subjects, often under challenging conditions. Special thanks are due the subjects, a highly motivated and dedicated group of Army aviators who must remain anonymous.

Sincere appreciation is extended to Mrs. Tina Pridgen and Miss Janice Stewart for their efforts in preparing this report.

AN EXPERIMENT TO EVALUATE THE TRAINING POTENTIAL OF THE PILOTS' NIGHT TRAINING DEVICE

BRIEF

Requirement:

Various constraints on low altitude night flying restrict the ability of Army aviation unit commanders to train their aviators in the essential pilot skills required for successful night terrain flight. Because of safety considerations, a shortage of instructors capable of teaching students night terrain flight missions, and various civil restrictions on low-level night flying, a requirement arose to develop a training device for "night" flying during the daylight hours. This requirement produced the Pilots' Night Training Device (PNTD) which, enabled pilots to fly during daylight hours but experience the effect of flying at night. The next step was to see how effective the PNTD was.

Procedure:

Sixteen recent graduates from the U.S. Army Aviation Center UH-1 Instructor Pilot (IP) course were assigned to participate. None had received Army school nor recent field experience in night terrain flight. The evaluators who measured pre- and posttest performances were two experienced night flight Standardization Instructor Pilots (SIPs) assigned to USAAVNC. All flights were made in the vicinity of Fort Rucker, AL. One group of eight pilots were trained at night while the other group was trained during the day wearing the Pilots' Night Trainig Device.

Findings:

There was little difference in performance between the two groups. What little there was probably amounted to the fact that one group of evaluators could critique their students in the daylight while the other evaluators observed their students during actual night conditions.

Utilization of Findings:

This experiment was conducted to find out if pilots wearing the PNTD and flying during the daylight hours performed as well as pilots who trained at night. Since the results show both groups performing equally well and seeing how flying during daylight hours has its logical advantages, it is recommended that the use of the PNTD be expanded.

AN EXPERIMENT TO EVALUATE THE TRAINING POTENTIAL OF THE PILOTS' NIGHT TRAINING DEVICE

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INTRODUCTION

"Among the technological races the US Army must run and win against potential enemies, few will have higher combat payoff than an edge in night fighting capability."[1]

The Army's concept of the employment of helicopters in combat requires night terrain flight as a principal means of increasing effectiveness and enhancing survival.[2] However, unit training in night terrain flying techniques is and has been difficult, sometimes virtually impossible, to conduct.

First, there are safety considerations; night terrain flight is hazardous. Second, there is a shortage of unit instructor pilots capable of training students to perform night terrain flight missions. Third, there are disruptions to circadian rhythms; studies have shown that aviators who are adapted to a daytime regime perform less well at night.[3] Finally, probably the most critical difficulty is that in many places there are local, civil restrictions on low level night flight. For example, at Fort Lewis, Washington, night flight off the post is not permitted below 2,000 feet. On the island of Oahu, Hawaii, where the 25th Infantry Division is stationed, flight is not permitted after 10:00 PM local time, and in the Federal Republic of Germany, where combat readiness is extremely critical, no night flight is permitted after 10:00 PM local time except in special and infrequent situations.

The need to develop a training device or technique that could be used by Army aviation units for night flight training in the face of these constraints was identified and reported by Canyon.[4] A prototype Pilots' Night Training Device (PNTD) was developed. Its

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[1]FM 100-5. *Operations.* Washington: Department of the Army, 1976.

[2]FM 90-1. *Employment of Army Aviation Units in a High Threat Environment.* Washington: Department of the Army, 1976.

[3]Colquhoun, W. P (Ed.). *Aspects of Human Efficiency.* London: English Universities Press, 1972.

[4]Long, G. E., Ciley, C. D., Jr., Hockenberger, R. L., and Garlichs, E. A. *Development of an Instruction Program for Individual and Unit Training With Combat-Ready Pilots, Task 1.* Canyon Research Group, Inc., Westlake Village, CA, December 1978.

design was based in part on the results of earlier research by ARI[5,6] on the use of light attenuating filters in simulating night visual conditions during the day. The purpose of the experiment described here was to test its effectiveness in training aviators during the day to fly night missions.

The specific objectives of the research were:

1. To determine whether aviators could be trained during the day with the PNTD to perform night terrain flight maneuvers.

2. To determine whether aviators trained to perform the night terrain flight maneuvers during the day with the PNTD could perform as well as a matched group of aviators trained at night to perform the same maneuvers.

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[5]Farrell, J. P. *Night Training by Simulating the Night Visual Environment During the Day.* Research Memorandum 75-4, US Army Research Institute for the Behavioral and Social Sciences, Washington, DC, 1975.

[6]Bleda, P. R. and Johnson, T. M. *Training in the Dark of the Day.* Research Memorandum 78-26, US Army Research Institute for the Behavioral and Social Sciences, Washington, DC, 1978.

METHOD

Subjects

Sixteen recent graduates of the US Army Aviation Center UH-1 Instructor Pilot (IP) Course were assigned to participate as subjects in the experiment.

UH-1 pilots were chosen for the experiment because the UH-1 is the predominant aircraft in the Army. These pilots were considered to be representative of working pilots in the field, and their successful completion of the IP Course confirmed their current proficiency in daytime operation of the UH-1 aircraft. A single stipulation in their selection was that they had not received previous Army school training nor intensive recent field experience in night terrain flight. During orientation, the subjects were told the nature of the experiment and their role in it. They also were told that none of the data regarding individual performance would be made available to anyone other than the research personnel.

Information on the subjects' experience and their attitudes regarding night flight is given in Appendix A.

Test Personnel

The Evaluators who measured the pretest and posttest performances were two of the most experienced night flight Standardization Instructor Pilots (SIPs) assigned to the USAAVNC. Their regular duty assignments were to administer the final performance tests to the graduates of night instructor pilot courses and the semi-annual flight performance tests to assigned night flight instructors.

The Instructors who trained the subjects were experienced night flight IPs assigned to the ARI Fort Rucker Field Unit.

The scientists/pilots who served as Recorders were trained and worked with their assigned Evaluator during all testing. In addition to recording the measurements given on each maneuver by the Evaluator, they independently recorded the radar altimeter readings.

PNTD

The PNTD was a standard Army Sand, Wind, and Dust Goggle frame in which a one-piece molded polycarbonate filter, having an optical density of ND 6.0, was fitted. Entry of light through the air vents around the frame was blocked with a strip of loosely fitted opaque material. A small diameter hose was bonded to a puncture in the goggle frame and attached to a funnel that was clipped to the window on the pilot's side of the aircraft. By mounting the funnel with its open end facing toward the rear, a partial vacuum was created by the passage of air across it. In flight, this resulted in a continual flow of air through the vents

and across the inside of the filter, thus reducing or eliminating condensation that otherwise could have occurred. Figure 1 shows the device with the Army flight helmet. Figure 2 shows the device as it was used in the UH-1 helicopter.

Testing and Training Areas

All flights were made in the vicinity of Fort Rucker, Alabama. The test flights were made in one area and the training flights in another. However, the two flight areas were similar. Each consisted of a hovering area; a large, unlighted, relatively level pasture surrounded by trees and well removed from cultural lighting; and a nearby terrain flight area--a course approximately twenty kilometers long over rolling, heavily forested terrain with scattered open pastures, ponds, and swamps. A panel of steel planking, painted white, was placed in each hovering area to provide a point of reference for the hovering maneuvers.

Design

A minimum number of subjects could participate at any one time. Therefore, the experiment was designed and scheduled to use two increments of eight subjects each. To control for possible variation in testing and training, the number of Evaluators and Instructors was kept to a minimum. Due to USAAVNC night training crew rest policies, each Evaluator or Instructor could administer flight performance testing or training for only two subjects per period, and only one period could be conducted on any one day or night. Table 1 illustrates the design of the experiment.

Table 1

Design of the PNTD Experiment

Pretest	Groups	Training Periods					Posttest
T_1	Group A Night Trained N = 8	1	2	3	4	5	T_2
	Group B PNTD Trained N = 7*	1	2	3	4	5	

*One subject was removed from flying status for medical reasons immediately following T_1 and just prior to the date his group was to begin training and did not complete the experiment.

Figure 1. The Pilots' Night Training Device and the funnel assembly used in reducing condensation on the inside of the lens.

Figure 2. The PNTD as worn by an aviator in the UH-1H helicopter. Note the mounting of the funnel on the pilot's side window.

Sixteen subjects were pretested (T_1) at night on their ability to perform basic terrain flight-oriented hovering maneuvers and to perform terrain flight over an unfamiliar course. The group was then divided into two matched groups on the basis of the ranks of their scores on T_1. Then each group was given five identical periods of training in the basic flying skills required to perform the pretest maneuvers. It might have been desirable to have had more than five training periods, but limitations in available aircraft hours and a requirement to return the subjects to their normal duties required that the training be kept to the minimum time in which some measurable training benefit might be expected to occur. The research personnel and Instructors agreed that five training periods was the minimum training time required to fulfill the purposes of the research.

One group (A) was trained at night. The other group (B) was trained in the same way in the same training area, but during the daytime using the PNTD. Because those pilots to be trained at night (Group A) were more likely to have their schedule interrupted by inclement weather they always completed their training before Group B began theirs. After the subjects in Group A completed their training, the schedule for the subjects in Group B was then adjusted (yoked) to be identical to that of the subjects in Group A with regard to the spacing of the training periods and the interval between their final training period and their posttest. A consequence of this procedure was that Group B had a longer interval (approximately 19 days) than Group A (approximately 3 days) between the completion of T_1 and the start of training. It was anticipated that if this difference in scheduling had any effect it would be detrimental to Group B, but there was no way in this experiment to determine the effects of the difference.

Upon completion of the training, the groups returned to the pretest area and again were tested on their flying performance at night (T_2). Pretest and posttest measures, and the test area used were identical.

Because the training and testing of the two increments of eight subjects had to be performed at different times, the ambient night illumination conditions during these testing periods had to be matched through the selection of appropriate test dates. The selection of dates was based on an Army study of hemispheric (moon) prediction.[7] The moon conditions on the dates selected for the posttest of a group were the same as the moon conditions the group experienced during its pretest.

Maneuvers

Measurements and assessments were made of the subjects' performance of the terrain flight related standard Night Hawk maneuvers listed in

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[7]Holman, Garvin L. *How High the Moon - How Bright the Night*. US Army Aviation Digest, September 1976, Vol 22, 9, pp. 6-19.

the Night Hawk/Night Vision Goggle supplement to the UH-1 Aircrew Training Manual[8] and the USAAVNC Initial Entry Rotary Wing Night Flight Training Guide.[9] The performance criteria used are specified in those documents. The maneuvers performed by the subjects were:

1. stationary hover (20 seconds)

2. landing from a hover

3. takeoff to a hover

4. 90 degree hovering turn

5. 360 degree hovering turn over a point

6. 360 degree hovering turn around a point

7. lateral (sideward) hover

8. mask-unmask (takeoff to high hover and landing)

9. contour (terrain flight) departure

10. terrain flight

Measurement Technique

As standard gradeslips used in routine training reflect the Army's criterion-referenced (satisfactory/unsatisfactory) philosophy, they do not provide the discrimination in performance measurement that was required for this experiment. Gradeslips providing greater discrimination were therefore developed for each maneuver and assembled into a grade book (see Appendix B).

The Evaluator used a simple code to report his measurements to the Recorder, a method designed to avoid providing feedback to the subject. The Recorder checked the blocks of the gradeslip corresponding to the reports given by the Evaluator.

The Recorder also recorded the radar altimeter (AN/ASN-209) readings, noting the highs and lows. During T_1 and T_2, such radar

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[8]TC 1-135. *Aircrew Training Manual, Utility Helicopter* (second draft). Washington: Department of the Army, 1978.

[9]Flight Training Guide. *Initial Entry Rotary Wing Course, Night Flight*. Fort Rucker, AL: US Army Aviation Center, 1977.

altimeter readings were recorded on all maneuvers except landing from a hover, mask/unmask, and contour departure. These radar altimeter readouts were not observable by the subject. Although the radar readings were not recorded during the training periods, they were used as a cross-reference by the Instructors to confirm the accuracy of their skid height judgments and to enable them to give more accurate feedback to the subjects.

Figure 3 is a reproduction of the gradeslip used in measuring the performance of the stationary hover. The numbers above the blocks were used in scoring the maneuvers. They were not printed on the gradeslips used during the data collection.

Additional Measurement

Questionnaires. A questionnaire designed to determine flight experience and attitudes concerning night flight was administered to the subjects before the experiment (see Appendix C). Another questionnaire regarding experience with the PNTD was administered after the completion of T_2 to each subject who used the PNTD (see Appendix D).

Dark adaptation. The dark adaptation of each subject was tested by members of the US Army Aeromedical Research Laboratory using a Gadman-Weekers dark adaptron. The results of these tests were used for screening purposes: all subjects were acceptable.

Illuminance. *Ambient illuminance at night in the test area was* measured using a Spectra [R]Pritchard[R] Photometer, Model 1980A. Weather data as officially reported by the US Air Force weather station at Fort Rucker were recorded.

Scoring System

A score of zero was assigned to performance that met the established criterion. The greater the deviation from the criterion the poorer the performance and the higher the score. In the case of the stationary hover, for example, the training literature[10] specifies that the skid height be three feet above the ground, plus or minus one foot. Therefore, any performance in which the Evaluator measured the skid height between two and four feet was scored as "zero." A skid height less than two feet or more than four, but less than six feet was scored "one." A skid height of more than six feet was scored "two." (See numbers above the blocks in Figure 3.) This scoring system was used unless an unsafe flight condition developed.

[10]TC 1-135. *op. cit.*, p. 6-22.

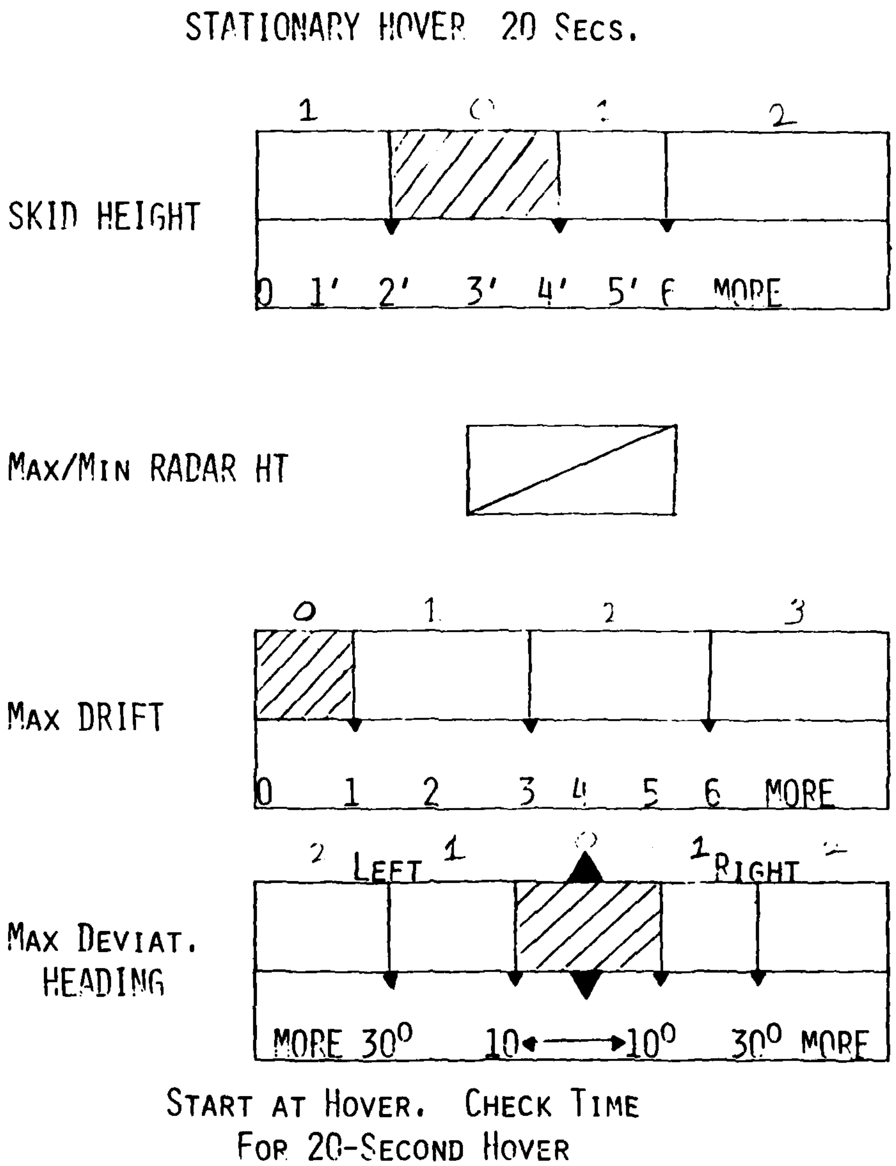

Figure 3.. Gradeslip used in recording performance of hover maneuvers.

NOTE: The numbers appearing above the blocks were used later in scoring the performance and did not appear on the gradeslip used in the experiment.

The range of deviations from criteria was based on recommendations developed from interviews with IPs and other subject matter experts. A major consideration in selecting the ranges was that they could be observed accurately by experienced Instructors and Evaluators.

During the development of the scoring system, a rule was established that if the Evaluator was required to assume control of the aircraft for safety, the maneuver would be terminated and the subject assigned the maximum (worst) score for that maneuver. In the case of stationary hover, the maximum score was 7. For the terrain flight maneuver, if the subject flew at such an altitude or airspeed that navigation could not be accomplished, the subject was assigned the poorest score, 14. The rationale for this scoring rule was that the purpose of terrain flight is to fly low enough to avoid detection and that success is dependent on accurate navigation. Therefore, a flight in which excessive altitude would have resulted in detection, or one in which excessive altitude or airspeed made navigation impossible, did not meet the *essential* criterion: completion.

The assessment of the subjects' performance and the subsequent scoring of the gradeslips were done after the flights were completed. Details of the scoring process were not revealed to the Instructors and Evaluators until after the entire experiment was completed. Subjects who requested the information were told privately of their performance test results at the debriefing.

Procedure

Prior to the experiment, the Instructors, Evaluators and Recorders practiced using the gradeslips in flight at night and with the PNTD during the day. The training and testing routes and locations were thoroughly reconnoitered and flown several times during the day and night. In flying together, the Instructors and Evaluators made an effort to standardize observational and measurement procedures.

Subject preparation. Initially, the subjects were tested to determine the rate of their dark adaptation. Then they completed the questionnaire (Appendix C) and received an orientation briefing on the experiment and brief refresher training on night vision. Finally, the pretest schedule was described.

Pretest procedure. In each pretest period, the preflight briefing was given in a darkened classroom in which red lights had been installed to assist in dark adaptation. The subjects were told about the test procedure. Further, they were told that the Evaluator would not give them any feedback regarding their performance and the subject occupying the passenger seat would not be allowed to monitor the aircraft intercommunication system.

During the preflight inspection and transit to the testing area, measures were taken to preserve the subject's dark adaptation. On arrival at the testing area the Recorder left the aircraft to measure the ambient illuminance.

T_1 for the first subject began no sooner than thirty minutes after the aircraft was started. The intensity of the aircraft instrument lights was adjusted as desired by the subject; the aircraft position lights were set "Steady-Dim." With two aircraft operating in the area, and the possibility that some other aircraft might attempt to use it, this minimum exterior lighting was necessary. The Evaluator then administered the pretest by asking the subject to perform the maneuvers in the gradebook, in order, making the measurements and announcing them to the Recorder until all were completed. After testing the first subject, the subjects changed places and the second subject was tested.

Assignment of subjects to training conditions. The subjects' performance on each measure of every maneuver performed during T_1 was ranked and the mean of the ranks was computed to provide an overall ranking. Then the highest and lowest ranked subjects were assigned to one group; the second highest and second lowest ranked were assigned to the other group, and so on. The choice of which group to train in what experimental condition was simplified by the fact that two aviators wore spectacles, and the design of the PNTD does not permit the use of conventional spectacles. Accordingly, the group which received those aviators as a result of the matching process became *ipso facto,* Group A, the group to be trained at night.

Training procedure. Except for the area in which the instruction was conducted, the training periods were similar to the T_1 periods described earlier. Dark adaptation was completed prior to arrival in the training area.

In the case of Group B, however, all training was conducted in daylight, and dark adaptation was more of a problem. Having the subjects wear red goggles prior to their departure to the training area was tried, but the dark adaptation process did not appear to be appreciably shortened. The procedure finally adopted was for the subjects to begin wearing the PNTD after the aircraft starting procedure had been completed. In cases in which the Device had not been worn at least thirty minutes by the time the aircraft arrived in the training area, the beginning of training was delayed until that time had passed. Some subjects seemed to adapt more quickly than others, but the "thirty-minute rule" was followed throughout the experiment.

The design plan was to have five training periods for all subjects on five consecutive nights, but inclement weather occurred during the training of the first increment of Group A, so the fifth period had to be postponed for one night. The yoking previously described then required that this schedule be followed for all subsequent groups. The schedule followed during the experiment is shown in Figure 4.

Increment One (N=8)

Group	Dates								
A	5	6	9	10	11	12	14	19	(April)
	T_1	T_1	TR	TR	TR	TR	TR	T_2	
B	5	6	26	27	28	29	1	6	(April-May)
	T_1	T_1	TR	TR	TR	TR	TR	T_2	

Increment Two (N=8)

Group	Dates								
A	5	7	9	10	11	12	14	18	(May)
	T_1	T_1	TR	TR	TR	TR	TR	T_2	
B	5	7	25	26	27	28	30	3	(May-June)
	T_1	T_1	TR	TR	TR	TR	TR	T_2	

Legend: T_1 = Pretest
T_2 = Posttest
TR - Training

Figure 4. Testing and training schedule.

Training Periods

Each subject was given five, 90 minute training periods on the nine maneuvers and the terrain flight route. The training included demonstrations, practice and Instructor feedback.

The training schedule was: thirty minutes proceeding to and returning from the training area; forty minutes equally divided among practice of the first nine maneuvers; and then twenty minutes on the terrain flight route. A refueling break was required between flight periods, at which time the subjects changed positions; the subject who piloted the aircraft

during the first period became a passenger on the second period. In an effort to balance any incidental learning and possible fatigue effects, the subject who flew first on one training period flew second on the next.

Posttest Procedure

The posttests were conducted in the same manner as the pretests. Each subject received both T_1 and T_2 from the same Evaluator, and the recording was done by the same Recorder.

RESULTS

Performance Scores*

As can be seen from Figure 5, the performance of both groups improved from T_1 *to* T_2; *this improvement was statistically significant* ($p < .01$) for both groups. Group B improved more from T_1 to T_2 than Group A and its performance on T_2 was better than that of Group A; neither of these results was statistically significant.

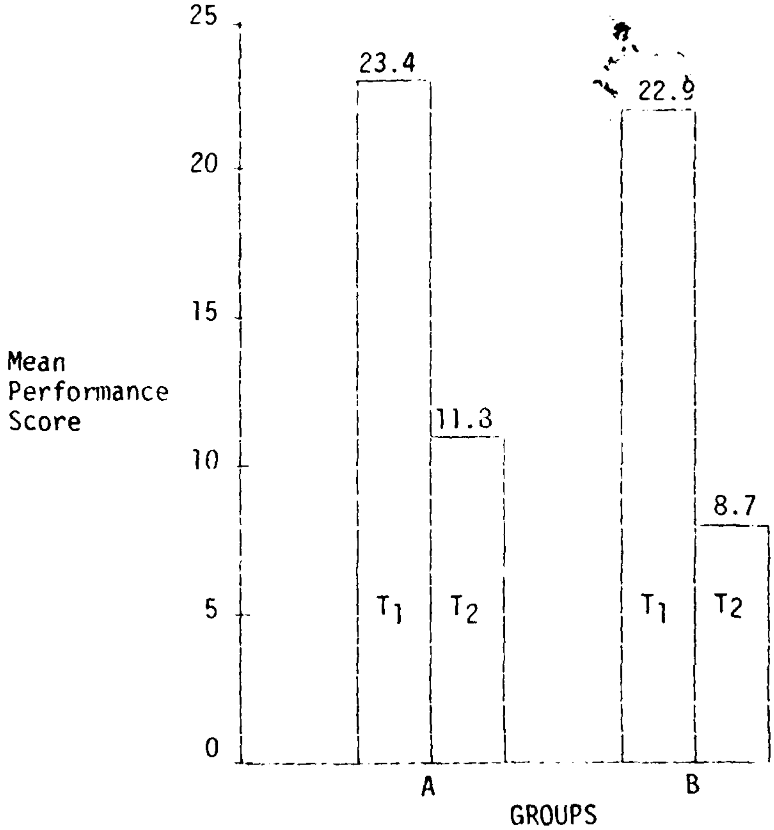

Figure 5. Mean Performance scores of Groups A and B on the Pretest (T_1) and Posttest (T_2). Note: *Higher scores denote poorer performance.*

*The raw performance data are presented in Appendix E. Included in that appendix are descriptions of practical considerations that required departure from the original experimental plan.

Table 2 contains a more complete description of the performance scores of the two groups than is illustrated in Figure 5.

Table 2

Ranges, Means, Standard Deviations, and Variances of Hovering Maneuver Performance Scores of Groups A and B on the Pretest (T_1) and Posttest (T_2)

GROUP	T_1 RANGE	$\bar{X}$	σ	σ^2	T_2 RANGE	$\bar{X}$	σ	σ^2
A (N = 8)	11 - 30	23.4	5.5	30.5	4 - 21	11.8	5.0	24.9
B (N = 7)	13 - 32	22.9	7.9	62.1	5 - 14	8.7	3.6	12.8

As indicated in Table 2, the relations between the mean scores and the ranges of individual scores showed that the distributions of performance scores were relatively symmetrical.

The variance of the performance scores of Group B on T_1 was almost twice the variance of the performance scores of Group A on T_1. But on T_2, the variance of the performance scores of Group B was about half the variance of the performance scores of Group A.

Skid Heights

A summary of the hover maneuver skid height data is presented in Table 3. Both groups performed better, i.e. more precisely, on T_2 than on T_1; Group B performed poorer on T_1 than Group A but better than Group A on T_2; but none of these differences was statistically significant. The variances of the hover skid height performance scores of both groups were less on T_2 than T_1, but again the differences were not statistically significant.

Table 3

Ranges, Means, Standard Deviations, and Variances
of Hovering Maneuver Skid Heights of
Groups A and B on the Pretest (T_1) and Posttest (T_2)

	T_1				T_2			
GROUP	RANGE	$\bar{X}$	σ	σ^2	RANGE	$\bar{X}$	σ	σ^2
A (N = 8)	3.8 - 8.2	6.4	1.4	2.0	3.8 - 6.8	5.3	.98	.96
B (N = 7)	4.5 - 12.3	6.7	2.4	5.8	2.6 - 6.5	4.5	1.2	1.5

The skid height terrain flight data shown in Appendix E indicated improvement in performance from T_1 to T_2; the pilots in both groups flew at lower altitudes on T_2. They were now flying "in the trees." However, because data were obtained from so few subjects and because detailed data regarding aircraft altitude and tree height at specific points on the route were not obtained, these findings should be treated with caution.

Training Data

The Instructors measured the performance of the subjects during each of the five training periods. The mean scores of the two groups for each period are plotted in Figure 6.

The two groups had been matched prior to beginning training, but the performance of Group B seemed to be much poorer than that of Group A during the first two periods; the difference on the first period was statistically significant ($p < .05$). The Instructors were questioned about this unexpected difference. They stated that, in their judgment, the two groups were near equal in performance, and that if higher scores (poorer performance) were being given to Group B, it probably was because they, the Instructors, were able to detect errors and make measurements more accurately while they flew in daylight.

Ambient Illuminance During Testing

Moon conditions (percentage of illumination and altitude above the horizon), illuminance, and the official weather observation for the Fort Rucker area, recorded during the experiment, are reported in Appendix F.

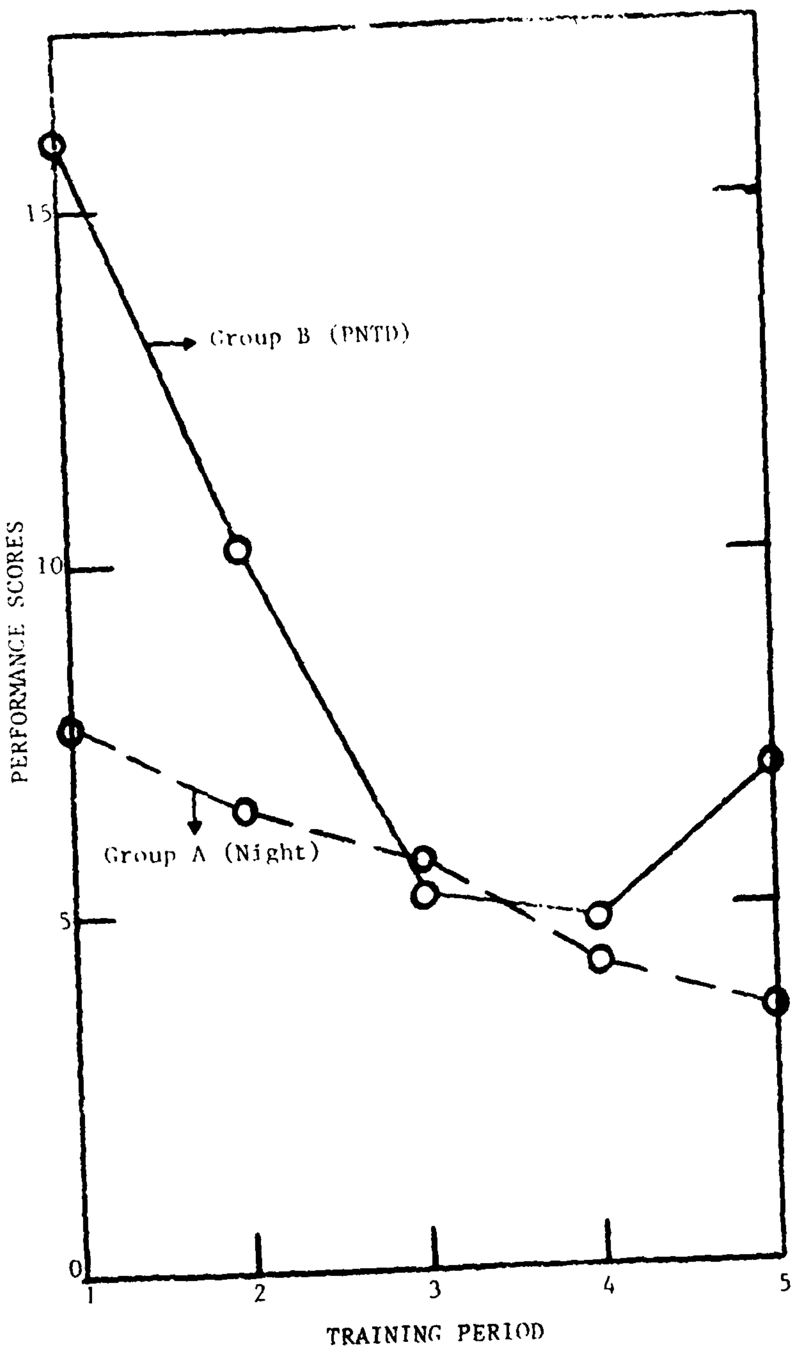

Figure 6. Mean performance of Groups A and B for the five training periods.

Comments and Questionnaire Data (Group B Only)

After they completed T_2, the seven Group B subjects were asked to respond to a questionnaire (Appendix D) regarding their experiences with the PNTD. A complete presentation of their responses is given in Appendix G. The principal findings were:

- The group was unanimous in expressing a strong desire to continue training with the PNTD, with the majority noting that its use gave them a capability to practice night terrain flight which had not been available to them before (Questions 18, 23).

- The "night scene" afforded by the PNTD was judged to be very much like that of actual night flight. Two of the subjects commented, however, that the absence of the accustomed glow of their aircraft position lights, when using the PNTD, deprived them of the use of texture and shadow in hovering (Questions 15, 21).

- The subjects felt that their learning through use of the PNTD was about the same as their previous learning at night (Question 17).

- Users of the PNTD felt safer and more relaxed than in their previous experience when they trained at night (Question 18).

- Users of the PNTD were less apprehensive about their training than those who received training at night (observation of Instructors).

- The PNTD group was highly confident of their ability to perform well during posttest (observation of Evaluators).

- Condensation was a problem; it was experienced to some extent by every subject. However, they were able to clear it and there was unanimous agreement that it had not interferred unacceptably with their training (Questions 9, 11, 12, 14).

- Some minor discomfort at the nose was experienced by most of the subjects. It was easily tolerated (Questions 2, 5, 6).

- There was a perceived need to provide visual access to the instrument panel (Question 20 and written and oral comments).

- Some true night flying should be interspersed in a PNTD-based training program to meet a perceived need to verify to the user that his learning does transfer well to the night environment (written and oral comments).

DISCUSSION AND IMPLICATIONS FOR FUTURE WORK

The finding that training with the PNTD appears to be at least as good as training at night is encouraging, but should, for a number of reasons, be interpreted with due caution. First, the number of subjects was relatively small; the training period was short; the number of maneuvers restricted, and the performance measures still may have contained a moderate subjective element. Certain variables such as illuminance and weather conditions could be observed and partial allowance made for their effects, but they could not be entirely controlled. Other variables such as the longer interval between T_1 and the start of training for Group B, and that Group A flew with the aircraft position lights on (for safety), were set so that if they had any effect it would probably mitigate against the group trained with the PNTD. There could be no control over others such as possible differences in the motivation of subjects or Instructors, only a confidence in the professionalism of these aviators.

Perhaps the most important finding of the experiment was that techniques learned with the PNTD *did transfer* immediately and well to true night flight conditions. The variance in the performance data on T_1 and T_2 is interesting. The marked difference in the variances on T_1 is undoubtedly a result of the group assignment procedure, but the variances on T_2 might indicate that some of the subjects trained at night were still having difficulties which was not the case for the PNTD trained subjects whose scores were more homogeneous, possibly indicating better training.

Use of the PNTD as a technique for teaching night terrain flight appears to offer a number of attractive advantages. First, the safety factor of conducting training during the day is a compelling argument for use of the Device. Further, in an emergency condition, an IP whose vision is not limited by darkness has a great many more options available to him than are available at night.

The effectiveness of the PNTD as a training aid is that it enables an IP *to provide more accurate and complete feedback* about the student's performance. One Instructor stated that, "At night, most of my attention is directed at surviving, but in daylight, I am more relaxed and I can divide my attention and provide much more instructional feedback."

During daylight training, an IP is also able to allow a smaller safety margin for error to the student who is developing his "night" terrain flying skills. The student knows that the IP's vision is unhampered by "darkness" and he is, therefore, more likely to accept criticism without reservation. The danger here is that the IP must keep in mind, and be able to appreciate, the limitations that have been imposed upon the subject's vision. Clearly, an IP must have personal experience with the Device, as did the Instructors used in this experiment, to be able to enhance the student's learning without exposing himself and his student to unwarranted risk.

It has been well established[11] that man's physiological, psychological, and social lack of adaptation to the night environment poses special problems for those responsible for conducting training at night. The ability to train night skills in the daytime offers at least a partial solution to these problems.

A further benefit of using the PNTD is that it offers probably the first viable alternative to the commander who has been forced to limit or even to eliminate night terrain flight training due to civil objections or other constraints.

Implications for Future Work

It is clear from the experimental results that there are issues which require early investigation. Some of these issues are discussed below.

Condensation. Although condensation apparently did not interfere with training during the experiment, it was bothersome, particularly when the humidity was high. At areas in which high humidity conditions prevail, the PNTD might not be usable without improvement or redesign. Two possible solutions should be investigated:

- An anti-condensation material to be applied to the inside of the filter. Candidate materials have been identified.

- A small electrically driven fan attached to the funnel assembly to increase the partial vacuum and speed the flow of air across the inside of the filter during hovering operations.

Illumination of the instrument panel. Currently, an aviator wearing the PNTD is unable to see the aircraft instrument panel. Although in hovering maneuvers and NOE flight he is trained to concentrate his attention outside the cockpit, the aviator has consistently expressed a need for occasional reference to selected aircraft instruments. During contour or low-level modes of terrain flight, reference to the instrument panel is a standard procedure. Thus, this current inability to see the instrument panel might unacceptably restrict the use of the PNTD for unit training.

It should be relatively simple to illuminate the instrument panel so that the pilot wearing the PNTD can see the instruments of interest to him. Use of a small hand-held light has been tested with some success. Testing of lights in various combinations of intensity and location should help in identifying optimum solutions.

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[11] Colquhoun. *op. cit.*

Emergency procedures training. The training and practice in flight of procedures designed to cope with aircraft emergencies that may occur during night terrain flight have been limited because of the hazard. Given a means of lighting essential aircraft instruments, an experiment should be conducted to determine the effectiveness of the PNTD in training night terrain flight emergency procedures.

Night terrain flight navigation. Given a means of lighting essential aircraft instruments and maps, the use of the PNTD in developing night terrain flight navigation skills under conditions in which no cultural lighting is available should be investigated.

Use in aircraft other than the UH-1. Although the PNTD has been used only in the UH-1 aircraft, there is little reason to believe it will not have utility in training in other Army aircraft. Nevertheless, some experimentation is advisable.

Unit training in maintenance of night flying skills. The Device has been shown to be effective in the school environment; its effectiveness in maintaining night terrain flying skills in aviation units should be tested.

Practice of war plans emergency night flying tasks. The usefulness of the PNTD as a daytime means of practicing anticipated high priority night combat missions in Europe and Korea should be tested on site. At present certain of these missions cannot be practiced at night.

CONCLUSIONS

1. Training for basic night terrain flight maneuvers was accomplished *at least as successfully* with the PNTD by day as it was using conventional training at night.

2. Daytime training using the PNTD offers several advantages over the alternative of training at night. Among these are greater safety and improved and more credible performance feedback from a more attentive IP to a more relaxed student. Additional advantages are no disruption to circadian rhythms and the ability to train in an environment free from cultural lighting and civil night flight restrictions.

3. There are a number of topics requiring further research before the PNTD should be offered to the Army for wide-scale use in operational aviation units. Methods must be developed for eliminating condensation on the filter and for lighting cockpit instruments, maps and perhaps landing areas. The use of the Device in the teaching of emergency procedures and navigation should be evaluated. Also, its use in other aircraft and as a means of practicing war plans emergency night flying tasks should be investigated.

REFERENCES

1. FM 100-5. *Operations.* Washington: Department of the Army, 1976.

2. FM 90-1. *Employment of Army Aviation Units in a High Threat Environment.* Washington: Department of the Army, 1976.

3. Colquhoun, W. P. (Ed.). *Aspects of Human Efficiency.* London: English Universities Press, 1972.

4. Long, G. E., Ciley, C. D., Jr., Hockenberger, R. L., and Garlichs, E. A. *Development of an Instruction Program for Individual and Unit Training With Combat-Ready Pilots, Task I.* Canyon Research Group, Inc., Westlake Village, CA, December 1978.

5. Farrell, J. P. *Night Training by Simulating the Night Visual Environment During the Day.* Research Memorandum 75-4, US Army Research Institute for the Behavioral and Social Sciences, Washington, DC, 1975.

6. Bleda, P. R. and Johnson, T. M. *Training in the Dark of the Day.* Research Memorandum 78-26, US Army Research Institute for the Behavioral and Social Sciences, Washington, DC, 1978.

7. Holman, Garvin L. *How High the Moon - How Bright the Night.* US Army Aviation Digest, September 1976, Vol. 22, 9, pp. 6 - 19.

8. TC 1-135. *Aircrew Training Manual, Utility Helicopter* (second draft). Washington: Department of the Army, 1978.

9. Flight Training Guide. *Initial Entry Rotary Wing Course, Night Flight.* Fort Rucker, AL: US Army Aviation Center, 1977.

10. TC 1-135. *op. cit.*, p. 6-22.

11. Colquhoun. *op. cit.*

APPENDIX A DEMOGRAPHY OF THE PNTD EXPERIMENTAL SUBJECTS

Demography of the PNTD Experimental Subjects

Question / 1. Subject Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2. Total Rotary Wing Flying Hours	700	2800	2500	1150	1200	800	1525	1600	1650	1300	1700	1700	1000	600	1000	1200
3. Night Flying Hours Last 6 Months	4	3	5	5	0	1	10	30	20	20	3	6	10	0	2	2
Last 90 Days	4	0	2	3	0	1	0.7	15	5	2	0	0	2	0	2	2
Last 30 Days	2	0	2	0	0	1	0.7	1	2	0	0	0	0	0	0	0
4. Date Rated as Army Aviator	6/73	5/70	1/70	3/74	7/78	4/76	7/72	6/74	12/69	3/71	11/69	9/71	5/76	3/72	12/75	10/62
5. Immediate Past Assignment: Non = Nonflying, Stf = Staff, Plt = Pilot, Civ = Civilian	Non	Non	Plt	Non	Plt	Non	Plt	Plt	(NG) Civ	(Res) Civ	Plt	Stf	Plt	Non	Plt	Stf
6. Duration Last Assignment (Months)	13-24	6-12	24+	13-24	6-12	13-24	24+	6-12	24+	24+	6-12	6-12	6-12	24+	24+	24+
7. Formal Night Hawk (NH) Training	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
8. If 7 yes, when attended	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9. Terrain Flight Without Night Vision Aids	No	No	No	No	No	No	No	Yes	Yes	Yes	No	No	Yes	No	Yes	No
10. If 9 yes, what mode: NOE = Nap-of-the-Earth, C = Contour, LL = Low Level	--	--	--	--	--	--	--	NOE	C	LL	--	--	C	--	LL	--
11. Attitude re: Night Flying: E = Enjoy, T = Tolerate, D = Dislike	T	T	E	D	T	T	T	E	E	T	E	T	T	T	T	T
12. Perceived importance of Night Terrain Flight: VI = Very Imp, Avg = No More/No Less, LI = Less Imp	VI	VI	LI	VI	VI	VI	VI	Avg	Avg	Avg	VI	VI	LI	Avg	Avg	VI
13. How peers perceive subject's proficiency: TMI = The Most Prof, VP = Very Prof, Avg = Average, NP - Not Prof	VP	Avg	NP	Avg	Avg	Avg	Avg	VP	Avg	VP	VP	Avg	TMI	Avg	NP	NP
14. Wears Spectacles at Night	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No

APPENDIX B GRADE BOOK

ARMY RESEARCH INSTITUTE

(CANYON RESEARCH GROUP, INC.)

EXPERIMENTAL GRADESLIP

BASIC MANEUVERS

FOR

NIGHT TERRAIN FLIGHT

PERIOD NUMBER ______________________

SUBJECT______________________

LAST NAME INITIAL

DATE______________________

IP______________________

LAST NAME INITIAL

AMBIENT LIGHT	PNTD	WX OBSN
________	FILTER USED (IF APPLIC)	
________	6 7	________
	CIRCLE ONE	

LANDING FROM HOVER

STEADY DOWN

STOPS	STEADY	TOUCHDOWN: HARD	NORM

MVMT @ T.D.

NO	FORE-AFT	LAT.	BOTH

MAX. DEVIAT. HEADING

LEFT RIGHT

MORE 30° 10°⟷10° 30° MORE

STATIONARY HOVER 20 SECS.

SKID HEIGHT

0 1' 2' 3' 4' 5' 6 MORE

MAX/MIN RADAR HT

MAX DRIFT

0 1 2 3 4 5 6 MORE

MAX DEVIAT. HEADING

LEFT RIGHT

MORE 30° 10°⟷10° 30° MORE

START AT HOVER. CHECK TIME FOR 20-SECOND HOVER

TAKEOFF TO HOVER 3'

CLOCK READY?

TIME TO STEADY (SECONDS)

FROM T/O 10 15 20 MORE

INITIAL SKID HEIGHT

0 1 2 3 4 5 6 MORE

MAX RADAR HT

STABILIZE SKID HEIGHT

0 1 2 3 4 5 6 MORE

MAX/MIN RADAR HT

MAX DEVIAT. HEADING

LEFT RIGHT

MORE 30° 10°⟷10° 30° MORE

MAX DRIFT

0 1 2 3 4 5 6 MORE

APPENDIX B (Cont'd)

90^{0} HOVERING TURN

START AT HOVER

SKID HEIGHT 0 1 2 3 4 5 6 MORE

MAX/MIN RADAR HT

MAX DRIFT 0 1 2 3 4 5 6 MORE

RATE STOPS STEADY FAST

STOP TURN LESS MORE -30° -10° +10° +30°

360^{0} HOVERING TURN

CLOCK READY?

START AT HOVER

SKID HEIGHT 0 1 2 3 4 5 6 MORE

MAX/MIN RADAR HT

MAX DRIFT 0 1 2 3 4 5 6 MORE

RATE STOPS STEADY FAST

CLOCK READY? TIME IN TURN (T_1,T_2)

STOP TURN LESS MORE -30° -10° +10° +30°

HOVER AROUND A POINT

START AT A HOVER

SKID HEIGHT 0 1 2 3 4 5 6 MORE

MAX/MIN RADAR HT

MAX DISTANCE 0 1 2 3 4 5 6 MORE

RATE STOPS STEADY FAST

STOP TURN LESS MORE -30° -10° +10° +20°

LATERAL HOVER

FROM A REST ON GROUND

SKID HEIGHT (FEET) 0 1 2 3 4 5 6 MORE

MAX.MIN RADAR HT

MAX DEVIAT. HEADING LEFT RIGHT MORE 30° 10° 10° 30° MORE

RATE STOPS STEADY FAST

MAX FORE-AFT DRIFT LESS THAN 3' 3 - 6' MORE

APPENDI B (Cont'D)

START ON GROUND

DISTANCE FROM BARRIER

LESS	1 ROTOR DIA.	MORE

MAX. DEVIAT. HEADING

MORE 10°		10° MORE

DRIFT @ LDG. FROM T/O POINT

0	6 FT	12 MORE

ASCENT-DESCENT

STOPS	STEADY	FAST

STARTS ON GROUND

STEADY CLIMB

STOPS	STEADY	FAST

HEIGHT OVER BARRIER (T_1 & T_2 ONLY)

INITIAL SPEED

WALK	RUN	TOO FAST: DISORIENTED

SINK

YES	NO

BALOON

YES	NO

TERRAIN FLIGHT

AIRCRAFT ALIGNMENT

USUALLY IN ALIGN.	OFTEN OUT OF ALIGN.	USUALLY OUT OF ALIGN.

ALTITUDE ABOVE TERRAIN/VEG.
RECORDER

BELOW 25'	25 TO 50'	ABOVE 50'

RADAR ALTITUDE
RECORDER

1	2	3	4	5	6

CHECKPOINTS

ABOVE 150' RADAR ALT

NO. TIMES	DURATION

ENROUTE GROUNDSPEED
RECORDER

DELIBERATE CONTROLLED	TOO FAST	DISORIENTED

TIME TO COMPLETE ROUTE (IP-RP)

YES	NO	TIME

COMPLETED

APPENDIX C PILOTS' NIGHT TRAINING DEVICE EXPERIMENT RESEARCH PARTICIPANT QUESTIONNAIRE

1. Name____
   Last Name First Name MI

2. Approximate number RW flying hours (total) ________

3. Approximate number night flying hours last:
   a. 6 mos ________
   b. 3 mos ________
   c. 1 mo ________

4. Date rated as Army aviator______________________________

5. Immediate prior assignment. Check one.
   Pilot duties ________
   Staff aviation duties ________
   Flying ________
   Nonflying ________
   Non-aviation duty ________

6. Duration of assignment above:
   a. Less than 6 mos ________
   b. 6 - 12 mos ________
   c. 13 - 24 mos ________
   d. More than 24 mos ________

7. Have you ever attended a formal (field or institutional) Night Hawk Course? Circle one. YES NO

8. If answer is yes, when?
   a. Last 6 mos ________
   b. 6 - 12 mos ________
   c. 13 - 24 mos ________
   d. More than 24 mos ________

9. Have you ever flown night terrain flight without night vision goggles (AN/PVS-5s)? Circle one. YES NO

10. If yes, what was the lowest terrain flight mode in which you flew?
    a. Low level ________
    b. Contour ________
    c. NOE ________

11. What are your feelings about being a pilot at night? (Check one, please.)
    a. Enjoy ________
    b. Tolerate ________
    c. Dislike ________

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12. How do you perceive the importance of the requirements to fly terrain flight at night without aids to vision (AN/PVS-5, FLIR, etc.)?
   a. The most important combat requirement ______
   b. Very important ______
   c. No more important than most other flying tasks ______
   d. Less important than most ______
   e. Not important ______

13. During your last flying assignment how do you think other Army aviators would have evaluated your flying proficiency in night combat-mission flying? Use scale below, please.
   a. One of the most proficient ______
   b. Very proficient ______
   c. Average ______
   d. Not very proficient ______
   e. One of the least proficient ______
   f. During that assignment, I did not participate in night combat-mission flying training. ______

14. Do you wear spectacles when flying at night? Circle one. YES NO

APPENDIX D PILOTS' NIGHT TRAINING DEVICE USER QUESTIONNAIRE

Canyon Research Group, Inc/Army Research Institute
Fort Rucker, Alabama

TO:

You recently participated in experimental testing of a concept involving the use of a light attenuating device--the Pilots' Night Training Device (PNTD)--in developing night terrain flight pilot skills. Your answers to the following questions and such other comments as you care to make regarding this experience with the PNTD would be greatly appreciated.

Your response will be used in identifying corrections needed in its present design and in developing the methodologies to be used in field testing and future use by Army aviators. This information will be used entirely for research purposes and any opinions quoted will not be attributed to any individual.

Please return the questionnaire and your comments, using the enclosed self-addressed envelope, not later than ____________________. You may sign the form or, if you wish, remain anonymous.

COLIN D. CILEY
Senior Scientist
CANYON RESEARCH GROUP, INC.

Pilots' Night Training Device

User Questionnaire

SECTION I - COMFORT

1. The longest time I wore the PNTD continuously during this experiment was: (Check one.)

   a. _____one hour or less

   b. _____between one and two hours

   c. _____two hours or more

2. Did you experience discomfort while wearing the device?

   a. _____yes

   b. _____no

IF QUESTION 2 WAS ANSWERED "NO" SKIP TO QUESTION 7.

3. If yes, did the discomfort begin after: (Check one.)

   a. _____30 minutes or less?

   b. _____between 30 minutes and one hour?

   c. _____between one and two hours

   d. _____two hours or more

4. Were you able to relieve the discomfort by periodic readjustment of the device?

   a. _____yes

   b. _____no

5. Was the discomfort: (Check one.)

   a. _____easily tolerated?

   b. _____tolerable but distracting?

   c. _____intolerable?

6. Where on your head did the discomfort occur? (Check one <u>or more</u>.)

a. _____nose

b. _____cheek

c. _____temple

d. _____forehead

e. _____other (please specify). ______________________________

____

SECTION II - CONDENSATION

7. Was a venturi funnel and tube used to reduce fogging on your PNTD?

a. _____yes

b. _____no

8. If your answer to Question 7 was "yes," was an anti-condensation (defogging) coating also applied to the inside of the PNTD lense? (Your IP would have advised you if so.)

a. _____yes

b. _____no

9. Did you experience condensation (fogging) on the inside of the PNTD lens?

a. _____yes

b. _____no

IF QUESTION 9 WAS ANSWERED "NO" SKIP TO QUESTION 15.

10. If your answer to Question 9 was "yes," did the fogging occur: (Check one <u>or more</u>.)

a. _____after brief hover? (10 minutes or less)

b. _____after prolonged hover? (more than 10 minutes)

c. _____enroute above translational lift speed?

d. _____enroute in slow flight below translational lift?

11. The customary method of eliminating condensation is to fly at an airspeed well above translational lift for a few minutes. Did use of this method remove the condensation in your case?

a. _____yes

b. _____no

12. If your answer to Question 11 was "no", what did you do about the condensation?

a. _____Nothing. The condensation did not interfere with the training.

b. _____Nothing. The condensation was distracting and interferred with training to some extent, but I was able to continue the training.

c. _____The flight was discontinued as no further training could occur.

d. _____Another method of clearing the condensation was used. (Describe briefly.) ______________________________

____

____

____

13. If you answered "yes" to Question 11, how often were you required to "clear" your device in this manner? (Check one.)

a. _____occasionally, on a few flights

b. _____occasionally, on most or all flights

c. _____frequently, on a few flights

d. _____frequently, on most or all flights

14. Did you find that the necessity to "clear" condensation interferred unacceptably with your learning?

a. _____yes

b. _____no

SECTION III - USE OF THE PNTD

15. After dark adaptation, how realistic was the "night" scene provided by the device? (Check one.)

a. _____unrealistic

b. _____somewhat realistic

c. _____realistic; very much like a real night scene

16. If your answer to Question 15 was "a" or "b", why? Because the scene was:

a. _____too bright?

b. _____too dark?

c. _____distorted?

d. _____other? Specify, please. ______________________________

____

____

____

17. In terms of the ease or difficulty you experienced in learning or improving your flying skills during the experiment, how do you compare that experience with your past experience in learning flying skills at night? (Check one.)

a. _____much more difficult than flying at night

b. _____more difficult than flying at night

c. _____about the same as flying at night

d. _____easier than flying at night

e. _____much easier than flying at night

DO NOT ANSWER THE NEXT QUESTION (18) IF YOUR ANSWER TO QUESTION 17 WAS A OR B.

18. If you believe you learned or improved your night flying skills through daytime use of the PNTD with about the same ease or easier than you were able to do during your previous learning experiences at night, what is the primary reason for that belief? (Check one.)

a. _____I felt safer and less constrained because I knew I was really flying in daylight, and that the IP could see.

b. _____It gave me the ability to practice night terrain flight (if you had been unable to practice night terrain flight before.)

c. _____I felt better physically because I remained on a daytime flying schedule.

d. _____Other. Please specify. ______________________________

____

____

DO NOT ANSWER THE NEXT QUESTION (19) IF YOUR ANSWER TO QUESTION 17 WAS C, D, OR E.

19. If you experienced more difficulty with the PNTD than at night, what do you believe was the primary reason? (Check one.)

a. _____the "night" scene was unrealistic

b. _____the PNTD was too uncomfortable

c. _____continuous condensation problems

d. _____other. Please specify. ______________________________

____

20. In your view, what is the most serious drawback to use of the PNTD in night flight training? (Check one.)

a. _____discomfort

b. _____condensation

c. _____lack of realism in the "night" scene

d. _____lack of visual access to the instrument panel of the aircraft

e. _____other. Please specify. ____________________________________

____

____

f. _____I see no serious drawbacks to its use.

21. Were there any visual cues which you use in actual night flight which you did not have when using the PNTD?

a. _____yes (please specify). ____________________________________

____

b. _____no

22. When did you get to like using the PNTD? Check one.

a. _____during the first period

b. _____during the second and third period

c. _____during the fourth and fifth period

d. _____never

23. Would you choose to do further training with them?

a. _____yes

b. _____no

24. Were there any maneuvers for which they were particularly helpful/ not helpful to your learning process?

a. _____ yes (please specify). ______________________________

____

____

b. _____ no

25. Please provide any other comments which you care to make on the PNTD and your experience with it. ______________________________

____

____

____

____

____

____

Signature (optional): ______________

APPENDIX E

Performance of Test Subjects on Pretest and Posttest (T_1, T_2)

Table E-1 reports the results of the pretests and posttests of all subjects. Various unplanned circumstances required departures from the original design of the experiment. They are explained below.

Subjects 1 - 4 did not carry out the three enroute terrain flight maneuvers (mask-unmask, contour departure, terrain flight), during their posttest (T_2), because the Army's entire UH-1 fleet was restricted from low altitude flight (other than hover) due to the safety-of-flight mechanical problem at that time. They did, however, carry out the seven "core" hovering maneuvers.

Subject 13 was removed from flying status for medical reasons just prior to the date his group was to begin training and he did not complete the experiment. His T_1 score was used in the matching of the two groups, but not in the final data analyses. In addition, aircraft maintenance problems delayed the conduct of T_2 for Subject 16 until after moonset. By the time he was ready to receive T_2 the moon had set, the weather had deteriorated, and the illuminance was 0.00006 foot-candles. Though faced with those conditions, Subject 16 carried out the first seven maneuvers, but the Evaluator stated that he was unable to conduct the last three (enroute) maneuvers safely.

In all, 15 subjects completed training. They were all tested in T_1 and T_2 on the "core" performance measures, i.e., the first seven (hovering) maneuvers. All these subjects carried out the three enroute terrain flight maneuvers during T_1 and the five training sessions, but only 7 subjects did so during T_2.

Table E-1

Performance of Test Subjects on Pretest and Posttest (T_1, T_2)

Group	Subject No.	Training Mode	Hovering Maneuvers		Mean Radar Skid Hgt (Feet)		Mean Skid Height During Terrain Flight (Feet Above Ground)	
			T_1	T_2	T_1	T_2	T_1	T_2
GROUP A	1	Night	11	10	3.8	3.8	137	*
	2	"	21	4	8.0	4.0	92	*
	3	"	26	11	7.8	5.3	125	*
	4	"	24	16	5.2	5.3	100	*
	5	"	29	15	6.2	5.5	87	80
	6	"	30	9	8.2	5.2	170+**	***
	7	"	24	21	6.2	6.8	99	83
	8	"	22	8	6.0	6.5	102	96
GROUP B	9	Day PNTD	26	5	6.5	3.5	132	58
	10	"	13	9	5.2	5.6	120	85
	11	"	32	13	6.7	4.7	111	83
	12	"	14	5	4.5	3.8	162	57
	13	"	27	****	5.7	****	106	****
	14	"	31	14	12.3	4.5	94	80
	15	"	15	5	5.3	2.6	90	79
	16	"	29	10	6.5	6.5	144	*****

*Subjects 1 - 4 not tested in terrain flight

**Safety abort; flight too high

***Safety abort; flight too low

****Subject medically grounded

*****Evaluator abort; not enough light

APPENDIX F MOON, ILLUMINANCE AND WEATHER CONDITIONS

Table F-1

Moon, Illuminance and Weather Conditions

Test	Date (1979)	Group Tested	Moon Condition	Illuminance (foot candles)	Weather Observation	
					Cloud Cover	Visibility
T_1	5 Apr	1st Increment	.56 @ $\pm$ 80^o	.0114	25 K Sct'd	15 miles
T_1	6 Apr	1st Increment	.65 @ $\pm$ 90^o	.0115	25 K Sct'd	7 "
T_2	20 Apr	1st "A" Sub-group	.47 @ $\pm$ 30^o	.0028	25 K Sct'd	7 "
T_2	6 May	1st "B" Sub-group	.67 @ $\pm$ 40^o	.0021	20 K O'cst	7 "
T_1	5 May	2d Increment	.58 @ $\pm$ 40^o	.0011	25 K Bkn	15 "
T_1	7 May	2d Increment	.75 @ $\pm$ 40^o	.0013	3.5 K Bkn	7 "
T_2	18 May	2d "A" Sub-group	.61 @ $\pm$ 30^o	.0022	Clear	10 "
T_2	3 Jun	2d "B" Sub-group	.51 @ $\pm$ 60^o	.0006	8 K Bkn	8 "

APPENDIX G

Table G-1

RESPONSES OF GROUP B TO PNTD USERS' QUESTIONNAIRE

Subject Number \ Question Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
S9	b	a	b	a	a	a	a	b	a	a,d	a	-	a	b	c	-	b	-	c	b	a	b	a	a
S10	b	b	-	-	-	-	a	b	a	b	a	-	b	b	c	-	c	b	-	d	b	b	a	b
S11	b	b	-	-	-	-	a	b	a	b	a	-	a	b	c	-	c	b	-	d	b	a	a	a
S12	b	a	b	a	a	a	a	b	a	a,b	a	-	b	b	c	-	c	a	-	d	b	c	a	a
S14	b	b	-	-	-	-	a	b	a	a	a	-	b	b	c	-	c	b	-	d	a	b	a	b
S15	b	a	b	a	a	a	a	b	a	a	a	-	c	b	c	-	b	-	c	b	a	b	a	b
S16	b	a	b	a	a	a	a	b	a	a,b	a	-	d	b	c	-	c	a	-	e*	a	b	a	b

*Restricted depth perception

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